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CRITICAL AND EXPLANATORY NOTES ON VITRUVIUS

BY MORRIS H. MORGAN

IN this article, which is a continuation of studies¹ undertaken during my preparation of a new translation of Vitruvius, I have endeavored, as heretofore, to understand him as we find him in the best manuscripts without having recourse to conjectural emendation,—a device which seems to me particularly out of place in the case of a document like the *De Architectura*, unique in its kind and therefore the more precious. I would not defend and trust that I never have defended monstrosities, whether of language or of syntax, but I confess that I am often readier to admit my own inability to understand the manuscript tradition than to distrust it. For on the whole it appears to be remarkably good, when we consider the unusual difficulties and peculiarities with which the mediaeval scribe had to contend. As for our author himself, his good faith is, I trust, no longer open to question, and I believe that he might truly have said with Condivi, the biographer of Michael Angelo: ‘E se punto laude me ne viene, mi contento che sia, non di buono scrittore, ma di raccoglitor di queste cose diligente e fidele, affermando d’ haverle raccolte sinceramente, d’ haverle cavate con destrezza e con lunga pazienza dal vivo oraculo suo: e ultimamente, d’ haverle scontrate e confermate col testimonio de’ scritti, e d’ huomini degni di fede.’

2, *praef.* 3 (32, 8): *animadverto si qui deduxerit eo loci coloniam fore ut iudicium eius vituperetur.*

Here *fore*, the reading of codd. E G S², is followed by the editors, while H and S have *forte*. Perhaps Vitruvius wrote *si qui forte deduxerit* and the scribe of the archetype of our manuscript having accidentally omitted *forte*, added it in his margin. Then the scribes of H and

¹ On the Language of Vitruvius, *Proceedings of the American Academy of Arts and Sciences*, XLI, 1906, pp. 467–502; The Preface of Vitruvius, *ib.* XLIV, 1909, pp. 149–175; Notes on Vitruvius, *Harvard Studies in Classical Philology*, XVII, 1906, pp. 1–14.

S took it as a correction of *fore* and so this necessary word disappeared from their text, while the scribes of E and G kept *fore* and neglected *forte*. For somewhat similar behavior by the different scribes in other passages, see Degering, *Berl. Phil. Woch.* XX, 1900, p. 11, and for *si qui forte* in Vitruvius, cf. 24, 10; 184, 22.

2, 3, 1 (38, 5) : *paleaeque in is non cohaerescunt propter asperitatem.*

Here the *Thesaurus* (s. v., p. 821, 72) refers *asperitatem* to *laterum*, that is to the bricks (*in is*) of which Vitruvius speaks in the passage. This is an oversight, for the context shows that it should be referred to the sandy or pebbly clay or gravel, against the use of which he is warning his readers. And the word does not mean 'dryness, barrenness of the clay,' as it is interpreted in Harper's *Lexicon*, but it is the literal 'roughness' of the material that makes the trouble. Vitruvius goes on to recommend another kind for its 'smoothness' (*propter levitatem*, 38, 7). In his next chapter, on sand, he uses *asperitas* (40, 6) as brickmakers now employ the word 'sharp.'

93, 1 ff. (4, 3, 6) : *Dividendae autem sunt in corona ima ad perpendiculum triglyphorum et medias metopas viarum directiones et guttarum distributiones, ita uti guttae sex in longitudinem, tres in latitudinem pateant. Reliqua spatia, quod latiores sunt metopae quam triglyphi, pura relinquuntur aut fulmina scalpantur, etc.*

In this passage Vitruvius uses the word *via* as an architectural term. It is not thus used, I believe, by any other Latin author, nor have I found ὁδός or any similar word thus employed in Greek. The unique usage, coupled with misunderstanding of the Vitruvian passage, has given rise to much confusion in modern writings. For instance, *viae* is taken as equivalent to *mutuli* in the general treatments of Doric architecture by Baumeister (*Denkmäler*, p. 265) and Durm (*Handb. der Architektur*, II, 1, p. 131); by Wiegand in his *Puteolanische Bauinschrift* (*Jahrb. f. Cl. Phil., Spb.* XX, 1894, p. 739); and by Reber in his German translation of Vitruvius. But Wiegand in a later work (*Porosarchitektur der Akropolis*, see especially pp. 16 and 57) and Perrault in his seventeenth century French translation apply it to the spaces or voids left *between* mutules; so also Dyer in his *Details of the Olympian Treasuries* (*Jour. Hellen. Studies*, XXVI, 1906, p. 82). Finally the Spanish translator Ortiz, the German Rode, and the English

Newton (and perhaps Gwilt, though his vagueness here, as in so many difficult passages, is provoking), refer it to the spaces or channels between *guttae*. Of these three different interpretations, the last seems to me to be the right one. To be sure, as one looks at the entablature of a Doric temple, the spaces between the mutules, being larger, attract more attention than the spaces between *guttae*, and we may well wish that there were a technical term in Latin with which to denote them. But if Vitruvius has already used *via* to denote something else, we ought not to select it to fill this want. Again, Vitruvius seems to apply the phrase *reliqua spatia* to the spaces between mutules. Finally (and, one may think, conclusively) Vitruvius says that the *guttarum distributiones* as well as the *viarum directiones* are over the *middle* of the metopes. How could the *guttae* be there, if *viae* denotes voids between mutules? As for the first interpretation, that *viae* means the mutules themselves, this can hardly be right because Vitruvius's word for mutules is *mutuli*; cf. for instance 89, 5; 7; 10; 27; 90, 2 and 7. Furthermore, the word *directiones* in his phrase *viarum directiones* shows that he does not mean mutules, because it is natural to believe that here as elsewhere he is using *directiones* in its proper sense of 'straight lines' (cf. 26, 24 *directiones vicorum*; 3, 24 *linearum directiones*; 23, 14 *platearum et angiporum directiones*), whereas mutules slanted downwards, as he well knew (cf. 89, 7 *mutuli inclinatis scalpulis*). The difficulty has really arisen because Vitruvius in his characteristic way has omitted to state in our passage that the *viae* and *guttae* were to be seen on the under surface of the mutules themselves; he is so anxious to tell us about their arrangement ('six *guttae* broad and three deep') that he omits to say just where 'beneath the corona' they were situated. He had already said (89, 6) that the *mutules* were beneath the corona, and perhaps he actually took it for granted that an intelligent reader might thus be led to understand, without being told, that the *guttae* and *viae* were part of the mutules! Instead of finding fault with him for his omission to mention the exact spot, we ought to be grateful to him for giving us our only piece of literary evidence that there were ever any *guttae* above triglyphs. Newton's explanation of the origin of this Vitruvian use of *via* is the best which I have seen; rendering 'the directions of the *viae*,' he adds this note: 'The *viae* I conceive to be the intervals or spaces between the *guttae*; and that

they are so called because they resemble the viae, or streets, about the islands of houses in a city' — that is, as we should say, about city blocks. The whole passage I translate as follows: — 'Set off on the under side of the corona, vertically over the triglyphs and over the middle of the metopes, are the viae in straight lines and the guttae arranged in rows six guttae broad and three deep. The spaces remaining (due to the fact that the metopes are broader than the triglyphs) may be left unornamented or may have thunderbolts carved on them.' It is clear, I think, that 'the spaces remaining' are the voids between one set of guttae with their surrounding straight 'streets' and the next set, — that is, between mutules. The thunderbolts would of course be carved on the soffits of the corona over these voids, so that one could look up from below at them as one looked up at the guttae.

5, *praef.* 1 (103, 7 ff.): *Non enim de architectura sic scribitur uti historia aut poemata. Historiae per se tenent lectores. Habent enim novarum rerum varias expectationes. Poematorum vero carminum metra et pedes, etc.*

I have printed the last six words as they stand in the best manuscripts, but it is obvious that both *poematorum* and *carminum* cannot be retained. Rose in both his editions followed Lorentzen in throwing out *carminum* as a gloss. But why should a word so readily understood as *poematorum* have been glossed, especially as it has just occurred two lines above and without a gloss there? Is it not more likely that *carminum* was the original reading and that it was glossed by *poematorum*, suggested by the foregoing context? This might seem to be the natural explanation of the double reading, whoever were the Latin author under consideration; but it becomes more than a probability when we have observed how constantly Vitruvius substitutes a synonymous word or phrase instead of repeating what he has already said. Attention has not hitherto been drawn, I believe, to this habit of his; but the fact is that, in view of what may be called the stylelessness of Vitruvius, one is sometimes tempted to assert that the device of using synonymes to relieve monotony was about the only stylistic principle of which he had much knowledge. And his employment of it is not confined to his rhetorical prefaces, for it appears frequently in the more technical parts of his work. Thus, in the third chapter of the tenth book (an explana-

tion of the motive principles of derricks and other hoisting machines), if a translator wishes to represent the Latin exactly, he will be hard put to it to render the simple idea of 'raising a load' in the six different ways by which Vitruvius expresses it: 252, 15, *onerum facere levationes*, 'accomplish the raising of loads'; 19, *onerum facit egressus in altum*, 'causes the load to move upward'; 22, *faciunt onerum elationes*, 'make the load rise'; 253, 2, *id onus extollit*, 'heaves up the weight'; 12, *pondus oneris erit excitatum*, 'the weight of the load will be raised'; 15, *onus elevare*, 'elevate the weight.' In the ninth chapter of this book he has two passages descriptive of exactly the same sort of a cog-wheel; in the first (263, 26) we read **super** (adverb) *autem tympanum planum eadem ratione dentatum* . . . (264, 7) **fiat** *foramen unum*; and in the second (265, 7) **insuper** (adverb) . . . *tympanum planum ad eundem modum dentatum* . . . (265, 15) *unum foramen excavetur*. Variation in prepositions is also not infrequent: a very striking example occurs towards the end of the second book (62, 1), *ideo infernates, quod ex apricis locis adportantur, meliores sunt quam quae ab opacis de supernatibus advehuntur* (observe also the different verbs in the two dependent clauses). A characteristically varied set of sentences is employed in the sixth book in the passage which treats of the proportions of the 'alae' of Roman houses (141, 10-19). Observe here how the five apodoses are expressed: *ex tertia parte eius constituitur; ex his una pars alis detur; quarta pars longitudinis alis tribuitur; ex his una pars fiat alarum latitudo; in quinque partes divisa longitudo iustam constituerit latitudinem alarum*. Compare in the third book his rules for calculating the diameter of a column at its necking (74, 7-22), noting the five different verbs with which the sentences end: *constituitur, fiat, perficiatur, habeat, contrahantur*. And see how he interchanges verbs which mean 'dissolve' in the third chapter of the eighth book (200, 4-19): *discutere, dissipare, dissolvere, dissilire*. Often he takes occasion to give Greek equivalents for Latin words, and then he almost always varies his verbs: for instance, in 150, 27: *nostri . . . xystra appellant, quae Graeci παραδρομίδας dicunt. Item προθυρα Graece dicuntur . . . nos autem appellamus prothyra quae Graece dicuntur διαθυρα . . . nostri telamones appellant . . . Graeci eos ατλαντας vocitant*. Compare with this the passages beginning at 150, 18; 243, 27; 252, 12; in 113, 14 we have *nominatur* with *dicitur* above and below; see

also 228, 4 and 7 (*nominant* and *vocant*). But this habit is not confined to verbs. Thus, in the eighth chapter of the fifth book, speaking of case endings, he uses the phrase *extremis casibus* (121, 13), but *novissimos casus* three lines below. In the same book, the idea of musical concord is expressed in one place by *consonantiae communitatem* (115, 18) and ten lines lower by *symphoniarum communitates*. Particularly striking is 101, 25: *Nonnulli etiam de Tuscanicis generibus sumentes . . . transferunt in Corinthiorum et Ionicorum operum ordinationes*; for here (and only here) he uses *ordinationes* when thinking of 'orders' of architecture and does so because he had already used his regular word *genus* in the same passage. Why does the strange term *thyromaton* appear in 96, 17 and *thyromatis* in 142, 16? Simply because in each case he had used respectively *ostiorum* and *forum* (from *fores*) two lines above. Compare also *aqua* and *liquoris* (139, 13 and 15); *fervor* and *calor* (189, 23 f.). But I need not enlarge upon this subject. Similar variations are constantly occurring on the pages of Vitruvius and they add not a little to the task of a conscientious translator. I have perhaps said enough to show why *carminum* rather than *poematorum* is the more probable reading in the passage with which this note began. Whether it means here 'poetry' or 'poems' (cf. 218, 2 *Accii autem carminibus*) does not matter. For *carmina* as opposed to *historiae*, see the examples collected in the *Thesaurus*, s. v. *carmen*, 467, 73 ff.; for instance, Sen. *Ep.* 33, 2, *eiusmodi vocibus referta sunt carmina, refertae historiae*.

5, 7, 1 (120, 10): *ab intervallo sinistro*.

In this expression (as well as in *ab intervallo dextro*, 120, 12), the word *intervallum* signifies 'horizontal distance' or 'distance in the same plane,' and it is equivalent to the geometrical expression *διάστημα τὸ πρὸς διαβήτην* (Heron, *Dioptra*, 218, 21 Schoene; cf. 222, 16 and 20, and see the note in Schmidt's Heron, Vol. 1, p. xxxiv). Vitruvius has a similar use of *intervallum* in 235, 18: *e centro aequinoctiali intervallo aestivo circinatio*, 'a circle from the equinoctial centre with a radius extending to the summer ray,' that is, to the point at which the summer ray cuts the circumference mentioned just above (235, 16). It may be noted that Vitruvius never employs *radius* to denote the radius of a circle.

5, 10, 4 (126, 11 ff.): *Magnitudines autem balnearum videntur fieri pro copia hominum. Sint ita compositae. Quanta longitudo fuerit, tertia dempta, latitudo sit praeter scholam labri et alvei.*

So the manuscripts, and Rose in his first edition. In his second he gives *pro copia hominum, <dummodo> sint ita dispositae*. The insertion of *dummodo* and the change from *compositae* to *dispositae* are drawn from Faventinus 300, 14, who has *magnitudines autem balnearum pro hominum copia aut voluntatis gratia fieri debebunt, dummodo cellae sic disponantur ut quanta longitudo fuerit tertia dempta latitudo disponatur*; compare also Palladius 1, 39, 3: *cellae autem sic disponantur ut quadrae non sint, sed verbi gratia si quindecim pedibus longae fuerint, decem latae sint*. But there are reasons why these later authors are dangerous guides in establishing the correct text of Vitruvius in this passage. In the first place they are speaking of baths in the houses of private gentlemen, while Vitruvius is describing a bathing establishment for a city. Secondly, they do not distinguish between the different rooms of a bath as Vitruvius does a few lines below (126, 20 *laconicum sudationesque, etc.*). Third, the verb *disponere* is never elsewhere used by Vitruvius when he is referring to proportionate dimensions, of which he is certainly thinking in our passage. He uses the verb frequently (see Nohl's index), but always in the general sense of 'arranging' or 'setting at intervals,' and never with proportionate measurements in his context. On the other hand, he does use *componere* in such contexts; cf. 127, 22: *laconicum ad eundem modum, quam supra scriptum est, compositum*, where the allusion is to the proportions of the *sudatio* given two lines above. See also 98, 4, *hyperthyra autem ad eundem modum componantur quemadmodum in Doricis, pro ratis partibus*. And cf. 117, 23 and 65, 9. For these reasons the text of Rose's second edition must be considered as very doubtful. But some emendation is necessary, for in spite of *magnitudines balnearum*, which would lead one to think that *compositae* refers to the proportions of the whole establishment, it obviously does not, but merely to those of a *caldarium*, as we see from the words *praeter scholam labri et alvei*, which can refer only to that room. And Vitruvius continues to deal only with that room until we reach *laconicum sudationesque* (126, 20). In fact, he has been dealing with it alone ever since 125, 14. Observing therefore that the word *caldariis* occurs in 126, 8, we must either think that three lines below,

in our passage, the word *balnearum* is used on his principle of variety (see what I have said above, p. 5), and hence keep the reading of Rose's first edition; or else we should suppose, not that *dummodo* has dropped out, but that we have lost some phrase (which must be feminine in gender) signifying the room called the *caldarium*. I prefer the former explanation, but in either case I should retain *compositae* unchanged. I may remark that the word *cella* is not found in Vitruvius to denote a room in a bath, though it is found in both Faventinus and Palladius. Does its occurrence in them suggest that it has dropped out of our passage, or is it further evidence that they were not following him slavishly?

5, 11, 2 (127, 18): *ad sinistram ephebei elaeothesium, proxime autem elaeothesium frigidarium.*

Here Rose in his second edition follows Marini (with a reference also to W. A. Becker) in reading <*tepidarium*> instead of *frigidarium*. Marini proposed this substitution because he thought that there ought to be a *tepidarium* at this point among the rooms of a Greek palaestra since one was placed there in a Roman bath (cf. 126, 20); and he also believed that *frigidarium* would mean the same as *frigida lavatio*, already mentioned two lines above in our passage. Becker also asserted this identity in his *Charicles* (2, p. 232, ed. Göll), stating that he had shown it in his *Gallus*. But no proof of such identity is to be found in the *Gallus*, either in Becker's own editions or in the revision by Göll. It seems more probable, however, that the *frigida lavatio* was merely a room in which one was washed off by a douche, not a room containing, like the *frigidarium*, a *piscina* for a plunge. The term *frigida* in Petronius (28) may refer to it; see Friedländer's note. In the same way *calidam lavationem*, occurring a few lines below (127, 23), should not be taken as the equivalent of the Roman *caldarium*. We do not know with exactness the arrangements for bathing in Greek *palaestrae* which Vitruvius is sketching in this chapter; see how cautiously Mau speaks of them in his article on *Bäder* (Pauly-Wissowa, p. 2744), where he remarks that no *tepidarium* is mentioned by Vitruvius in our passage. I therefore retain the reading *frigidarium*.

5, 11, 4 (128, 18) : *post xystum autem stadium.*

It is more than doubtful whether *xystum* (acc. sing. masc.) of the manuscripts should be changed to *xysta* (neut. pl.), which appears in Rose's second edition. We know nothing actually (except from this passage) about the position of the stadium with reference to the other parts of normal *palaestrae*; see Fougères in Daremberg and Saglio's dictionary (s. v. *gymnasium*, p. 1691). Vitruvius may be mistaken in placing it behind the *xystus* rather than behind the *xysta*, but his error, if it be such, calls for a note rather than for a change in the text. He has very carefully distinguished between the words *xystus* and *xysta* (neut. pl.) throughout § 4 here and also elsewhere (150, 25-151, 1).

6, *praef.* 6 (133, 26) : *qui non modo architecturae sed omnino ne fabricae quidem notitiam habent.*

The insertion of a second *non* after *modo* in Rose's second edition is quite unnecessary. It cannot be justified as a habit of Vitruvius, for there is no other sentence of this kind in his work. And that *non modo non* in such sentences is the exception, not the rule, is well known; see Schmalz, *Lat. Gr.*³, p. 353. The presence of *omnino* does not require it; cf. Cic. *Parad.* 5, 33; *Fam.* 9, 15, 4.

6, 2, 4 (139, 26) : *sed ita uti nihil in his operibus desideretur.*

Müller-Strübing's omission of *sed*, adopted in Rose's second edition, seems unfortunate. The phrase *sed ita uti* is corrective in nature, as in 107, 28: *Aerarium, carcer, curia foro sunt coniugenda, sed ita uti magnitudo symmetriae eorum foro respondeant.* In our passage Vitruvius is referring back in thought to 139, 4, *uti id videatur recte esse formatum in aspectuque nihil desideretur*, and so he says: 'the diminutions or additions should be made, *but* in such fashion that the buildings lose nothing thereby.'

6, 6, 7 (148, 24) : *itineribus, clivis, scalis.*

Vitruvius is talking about windows and says that they are particularly necessary in parts of buildings where people carrying burdens are apt to meet and run against one another, if light is not provided. As such places he specifies *itineria*, *clivi*, and *scalae*. By *itineria* he must mean ordinary passageways with level floors, and by *clivi* passageways with inclined floors. I have not found *clivus* used by any other author to

denote such a thing, and the only lexicographer who has booked the usage seems to be Georges. The *Thesaurus* has not yet reached this word. But I observed a good example of such an incline leading to a cellar in the House of the Centaur at Pompei. Another, not leading to a cellar, but to a back door from a higher level, is mentioned by Overbeck (*Pompeji*⁴, p. 342) as found in the House of Castor and Pollux. An English translator cannot use the word 'ramp' to render *clivus* (as a German or French translator might), because in English usage it appears to be confined to fortification. We have no special term for such a passage inside a house, and must therefore use some such phrase as 'in passages, level or inclined' to translate *in itineribus, clivis*.

6, 7, 3 (149, 24): *porticusque peristylorum albariis et tectoriis et ex intestino opere locunariis ornatas*.

Here Vitruvius, speaking of Rhodian peristyles, says that their colonnades are 'adorned with polished stucco in relief and plain, and with coffered ceilings of woodwork.' He distinguishes between *albaria* and *tectoria*. This is also the case in 126, 7, *opere albario sive tectorio*, where *sive* appears instead of *aut*; cf. 94, 22 and my *Language of Vitruvius*, p. 486. In two other passages he uses *opus albarium* of the cornices in a senate house (108, 8) and in Corinthian oeci (143, 17), where stucco worked in relief must be meant; for he is thinking of the cornices which he calls *coronae caelatae* in the third chapter of his seventh book (167, 9 and 13). He there uses *album opus* (167, 13) of the same form of decoration; but a little below, where he refers to flat or plain stucco on which fresco painting is to be done, he always uses *tectorium* (167, 20; 168, 10 and 17; 169, 1, etc.). Only in one passage does he use the adjective *albarium* in a general sense, where he has no need of distinguishing between the plain and enriched form of stucco work (*de albariis operibus*, 165, 14). He never uses *tectorium* of enriched stucco. For the distinction, see Pauly-Wissowa, s. v. *albarium*, where, however, there are several misprints in the references.

8, 3, 20-23 (200, 24-202, 20).

In this passage, which contains the three Greek epigrams, my examination of cod. H itself and of photographs which I have of these pages, shows that the readings from it, cited by Rose in his apparatus, are in

a few cases incorrect. The differences are not important, but for the sake of exactness I give them here: 200, 24 *exco*, not *ex quo*; 201, 8 ΜΕCΕΜΒΡῑNON, not -CHM-; 202, 1 ΜΟΝΕΚΟΥ, not -CKΟΥ; 202, 14 *graecae*, not *graece*; 202, 20 (at the end of the epigram) eaH, not eaN. Hence in this last passage, the Harley manuscript preserves the letter η which we need for the correct reading εδη, although in the first passage it gives ε for η (as is said to be always the practice of cod. G).

8, 6, 13 (211, 6): *cum ad aquam erit perventum tunc saepiatur structura ne obturetur vena.*

I read *structura* here with codd. E G S, instead of *astructura*, which is given in Rose's second edition and which is drawn from the erroneous *saepiaturas structura* of cod. H. No such word as *astructura* is entered in the *Thesaurus*, and we want here only an ordinary word for a stone wall. Vitruvius is speaking of wells and the passage which I have quoted means: 'When water is reached, then a wall should be built round the well without stopping up the vein.' Rose's reference in his apparatus to Faventinus 291, 25 is particularly unfortunate, for there the wall is to be of 'signinum work' (*cum aqua inventa fuerit signinis operibus parietes struantur*), which is exactly what you do not want in a well, as it might stop up the vein. Hence Pliny says (*N. H.* 31, 49) *cum ad aquam ventum est, sine harenato opus surgit ne venae obstruantur*. He does not permit the use even of sandmortar in his wall. Rose's reference to Palladius (9, 9, 2: *latera puteorum structura suscipiat*) is to the point; for the object of the wall is merely to prevent the well from falling in.

8, 6, 14 and 15 (211, 7-23): *Sin autem loca dura . . . et extenuari.*

These two sections are entirely devoted to an account of cisterns for the storage of water. Vitruvius finished his treatment of wells with the words at the end of section 13, which I have just cited in the preceding note. Pliny (also cited above) stops at the same point, passing immediately to the temperature of well water and saying nothing about cisterns until considerably later in his work (36, 173), where he summarizes in two sentences what Vitruvius takes two sections to tell. On the other hand, in Faventinus (291, 25-292, 7) and Palladius (9, 9, 2:

quae structura . . . 3, salis admixtione corrigetur) we find applied to wells what Vitruvius has said about cisterns. This is, I think, because Faventinus (whom Palladius followed) in epitomizing Vitruvius took *fossa* in 211, 14 as applying to a well, since Vitruvius had used the verb *fodere* and the substantive *fossio* each twice in connection with wells in section 12 (210, 19; 20; 27; 28). Rose, also, in the critical note in his second edition refers *fossa* in 211, 14 to wells. But I believe that this *fossa* denotes the excavation or trench made as the first step before constructing cistern walls of 'signinum work'; cf. the use of *foditur* in 171, 14, where an excavation is made before laying the paved floor of a triclinium. Hence, with the word *eorum* in *eorum fossa ad libramentum altitudinis quod est futurum calcetur vectibus ligneis ferratis* (211, 14), Vitruvius points us back to *signinis operibus* (211, 9), and the sentence means: 'the trench for the signinum work down to the level of the proposed depth <of the cistern>, should be beaten with wooden beetles covered with iron.' This beating process is preliminary to the application of the signinum work (cf. a similar preliminary beating before the laying of the pavement of the aforesaid triclinium: 171, 15, *solo festucato inducitur aut rudus aut testaceum pavementum*); then with the words *parietibus calcatis* (211, 15), Vitruvius, assuming in his provoking way that the walls of signinum work are already built, says that these walls must themselves undergo a beating. (So, too, must the pavement of the triclinium in 171, 17, *congestis et spisse calcatis*, etc.) With this explanation, there is no need of assuming, with Rose and others, a lacuna before *eorum*; and Degering has already remarked that there is none, as Rose thought, after *fuert* in 211, 18 (cf. *Berl. Phil. Woch.* XX, 1900, p. 13). The fact is that we should not fancy that every statement in Faventinus was based upon something which stood in Vitruvius before there were any lacunae in his text. It is often forgotten that Faventinus at the very opening of his work says himself that Vitruvius is not his only source. And consider, for example, his statement that some say that there are twelve winds (not eight as in Vitruvius), and his description of the bronze triton in Rome that served as a weather cock, imitated from the triton in Athens described by Vitruvius (cf. Fav. 289, 1 ff.; Vit. 25, 3 ff.). Returning, therefore, to our passage, we find Faventinus unnecessarily giving proper dimensions for a well (292, 1; followed by Palladius 9, 9, 2), though Vitruvius and

Pliny (31, 49) say nothing on this detail; and in 292, 13 ff. Faventinus (cf. Pallad. 9, 9, 3) suggests the propping up of the sides of wells with transverse beams during the digging, a point on which Vitruvius and Pliny are both silent. Again in 292, 8, Faventinus remarks that while the *auctores* prefer to mix their sand for signinum work in the proportions of five parts of sand to two of lime (which are the proportions actually given by Vitruvius 211, 13, and Pliny 36, 173), it has been found better to make the mixture in the proportion of two to one. On the other hand, the clearing basins recommended for cisterns by Vitruvius (211, 18 ff.) and Pliny (36, 173) are naturally omitted by Faventinus (and by Palladius after him), for of course he could find no place for them in the 'well' which he thought that Vitruvius was describing! The two sections which we have been considering may be translated as follows, remembering that they are immediately preceded by two sections on wells: 'But if the ground is hard or if the veins lie too deep, the water supply must be obtained from roofs or higher ground and collected in <cisterns of> signinum work. Signinum work is made as follows. In the first place, procure the cleanest and sharpest sand, break up lava into bits of not more than a pound in weight, and mix the sand in a mortar trough with the strongest lime in the proportion of five parts of sand to two of lime. The trench for the signinum work, down to the level of the proposed depth <of the cistern> should be beaten with wooden beetles covered with iron. Then after having beaten the walls, let all the earth between them be cleared out to a level with the very bottom of the walls. Having evened this off, let the ground be beaten to the proper density. If such constructions are in two compartments or in three so as to insure clearing by changing from one to another, they will make the water much more wholesome to use. For it will become more limpid and keep its taste without any smell, if the mud has somewhere to settle; otherwise it will be necessary to clear it by adding salt.'

10, 1, 4 (245, 9): *et ita quae animadverterunt ad usum utilia esse studiis artibus institutis, gradatim augenda doctrinis curaverunt.*

Instead of *artibus*, Rose² substitutes *artium*, an unnecessary change, which would apparently give an ablative absolute in *studiis artium institutis*, 'they began to study the rules of it.' But have we not here three datives with *ad usum utilia*? The meaning would then be: 'and so

whatever they found to be practically useful to investigations, to the arts, and to established practices, they took care to improve step by step on scientific principles.' With *ad usum utilia*, cf. 171, 13, *ad hibernaculorum usum . . . utilis*; and for the dative with *ad usum* (accompanied not by *utilis*, but by a different adjective), cf. 37, 31, *aptas ad usum copias aedificiis*, and 177, 23, *id autem multis rebus est ad usum expeditum*. For *studia* in the sense of 'investigations,' cf. 233, 5 and perhaps 127, 11; for *instituta*, 'practices,' cf. 151, 18 and 174, 25.

10, 2, 14 (251, 18): *pecuniam contricavit*.

This phrase is used of the unfortunate individual who took a contract to quarry and transport a new pedestal for a statue of Apollo and tried to transport the huge stone from the quarries by a method of his own. In the course of it, *pecuniam contricavit ut ad solvendum non esset*. The manuscripts all have *contricavit* (a verb which has not been found elsewhere in Latin), but the editio princeps and all subsequent editions have *contrivit*. Vitruvius uses the verb *conterere* elsewhere three times, but never in a metaphorical sense, so that the emendation is not in itself attractive. And it is quite unnecessary, for the substantives *tricae* and *trico* as well as the verb *tricari* and compounds of *tricare* are all found in contexts in which financial matters are under consideration. See for instance Marx's note on Lucilius 11, 413-417; Cic. *Att.* 15, 13, 5; and particularly the accusative construction used with *extricare* (as here with *contricare*) in Hor. *Sat.* 1, 3, 88, *mercedem aut nummos unde unde extricat*, wherein is described a result which is the opposite of that which we find in our passage. Lindsay in his *Latin Language*, p. 58, says: 'the word *tricae*, whose origin has been traced to S. Italy, where the word was applied to hair-shackles put on the legs of fowls to prevent their straying,' etc. (see Nonius, s. v. 8, 11 ff.). In Vitruvius, therefore, we see that the unlucky contractor 'tied up his money' in his unsuccessful operations, or as we should say 'fell into financial embarrassment.' In this sense *conturbare* is not uncommon; see the *Thesaurus*, s. v. 808, 6-20; also Oudendorp's Suetonius, 1, p. 227, where he speaks with doubt of the adoption of the reading *contrivit* in Vitruvius. Of the phrase *ut ad solvendum non esset* (251, 18) I have already spoken in my *Language of Vitruvius*, p. 485.

But there I had no occasion to say anything on the name of the person about whom Vitruvius tells this story. In the earlier editions it appeared as Paconius, but, beginning with Schneider, all editors have since followed Oudendorp's correction (*l. c.*) to Paeonius. The name occurs three times in the anecdote. Twice the best manuscripts agree upon Paconius (251, 6 and 8), and once upon Paeonius (251, 17), though here the corrector of cod. G restored the former name. As the event described is attributed by Vitruvius to his own times (*nostra memoria*, 251, 3; cf. my remarks in *Harvard Studies in Cl. Phil.* XI, pp. 11 f.), there can be no question here of the Greek *architect* Paeonius (161, 7 and 9), who lived much earlier. Moreover, our passage (251, 5) shows that we have here a mere contractor: *locaverunt ex eisdem lapidicinis basim excidendam. Conduxit quidam Paconius*. With this cf. Vell. Pat. 1, 13, 4, *Mummius tam rudis fuit ut capta Corintho, cum . . . tabulas ac statuas in Italiam portandas locaret, iuberet praedicti conducentibus*, etc. Our contractor may well have been a Roman, not a Greek at all; or he may have been a nondescript character like his namesake who is stigmatized by Cicero: *Paconi nescio cuius, hominis ne Graeci quidem ac Mysi aut Phrygis potius* (*Q. F.* 1, 1, 19). Let us therefore read *Paconius*, with the weight of manuscript authority, throughout the anecdote.

10, 3, 4 (253, 23): *paulo et inpari pondere amplissimam pensionem parem perficit per scapi librationem examinatio*.

This passage may be rendered: 'a small and inferior weight becomes equal to a very heavy object that is being weighed, on account of the equilibrium that is due to the levelling of the beam.' Here *pensionem* does not signify a 'weight' used as a counterpoise (as it does in 269, 12), for the counterpoise is here denoted by *pondere*. In this latter word we perhaps have an instance of the somewhat rare use of the ablative with *par*, a construction noted by Schmalz (*Lat. Gramm.*³, p. 254) as found in Plautus, Cicero, Sallust, and Ovid. Vitruvius does not use the construction elsewhere; he has the dative twice (26, 2; 28, 23) and the ordinary ablative of measure once (149, 19). Generally he employs *par* to modify a substantive in the ablative of quality (see Nohl's *Index*).

10, 3, 5 (254, 1 ff.): *quemadmodum etiam navis onerariae maximae gubernator ansam gubernaculi tenens, qui οἰαξ a Graecis appellatur, una manu momento per centrum pressionibus ratione artis agitans, versat eam amplissimis et inmanibus mercis et penus ponderibus oneratam.*

In this passage the manuscripts have *per centrum ratione pressionibus*, but the order of the last two of these words was corrected by Schneider and his change has won general acceptance. Torr, however, in his excellent book on *Ancient Ships* (p. 76) reads *per centri librationem pressionibus*, apparently not observing that the manuscripts have *centrum*, and accounting for his change of *rationem* (which accusative he seems to think is found in the manuscripts) to *librationem* by referring to *per scapi librationem* in Vitruvius's preceding problem on the steelyard (253, 23). But the parallel is not a just one. In the steelyard the beam (*scapus*) can be brought to a level, but how can a *centre* be so brought? Next, Torr takes *artis* as coming from the adjective *artus* and makes it agree with *pressionibus*, which is for two reasons an unfortunate interpretation: first, because Vitruvius never elsewhere uses this adjective; and secondly, because the whole point is that the pilot is not obliged to exert a *severe* pressure in order to turn the ship. The source of the problem lies, as Torr notes, in Aristotle (*Mechan.* 6; cf. Schmidt's Heron, 1, p. xviii f.), and Aristotle says: ὑπὸ μικροῦ οἰακος καὶ ἐνὸς ἀνθρώπου δυνάμει, καὶ ταύτης ἡρεμαίας. In Vitruvius, therefore, *artis* is from *ars*, and *ratione artis* refers to the rules of the art of steering. The whole passage may be rendered thus: 'So, too, the pilot of the biggest merchantman, grasping the steering oar by its handle (which the Greeks call οἰαξ) and with one hand bringing it to the turning point, according to the rules of his art, by pressure about a centre, can turn the ship although she may be laden with a very large or even an enormous burden of merchandise and provisions.' It may be added that both Aristotle and Vitruvius in this problem distinguish between the steering oar (πηδάλιον, *gubernaculum*) and its handle (οἰαξ, *ansa*); also that *momento*, as in Vitruvius's preceding problem on the steelyard (253, 25) means 'turn of the scale,' 'turning point' (cf. Schmidt's Heron, 2, p. 382 ff.).

10, 3, 9 (255, 19 ff.): *tunc vero etiam plostra raedae tympana molae coeleae scorpiones ballistae prela ceteraeque machinae isdem*

rationibus per porrectum centrum et rotationem circini versando faciunt ad propositum effectus.

These words, with which Vitruvius concludes his chapter on the Elements of Motion, may thus be translated: 'so also farm wagons, travelling carriages, drums, mills, screws, scorpiones, ballistae, press-beams, and all other machines produce the results intended on the same principles, by turning about a rectilinear axis and by the revolution of a circle.' To understand how Vitruvius comes to use *per porrectum centrum* to signify 'by turning about a rectilinear axis,' we must go back to the beginning of the chapter. In the first section of it, he states that the right line (*porrectum*, 252, 12) and the circle (*rotunditas*, 252, 13) are the elements of motion in hoisting machines (which he has been describing in his preceding chapter). Then, in the second section, in which he is still speaking of these machines, we have the words *inducuntur uti centra axiculi* (252, 16), where the axles of sheaves in blocks are regarded as centres, and of course these axles are 'inserted' in right lines, though he does not say so. Then, in *cuius suculae cardines uti centra porrecti in chelonii* (252, 20), the pivots or ends of a windlass are regarded as centres: they 'lie as centres in right lines in its socket pieces.' Further, in *supposita uti centro porrecta pressione* (252, 25), the fulcrum (*pressione*) of an iron lever is said to 'lie as a centre in a right line under the lever' (i. e. transversely under it). Next, in *ab ea pressione quod est centrum* (253, 3), the fulcrum of a lever is said to be the 'centre.' Passing over his exemplifications of these principles in the cases of steelyards, steering and other oars, sails, porters' poles, and yokes for oxen, we approach the end of the chapter, where in *ad centrum porrectionibus et circinationibus* (255, 18) it is stated that, in the case of poles and yokes, motion is obtained 'by right lines at the centre and by circles'; here the phrase 'by right lines at the centre' denotes what corresponds to the 'axle' in the case of sheaves in blocks. Hence, in the last words of the chapter, which I have quoted at the beginning of this note, *porrectum centrum* is the rectilinear axle of a vehicle, mill, or the like; and the 'circle which revolves' (*rotationem circini*) is, for example, the wheel of a vehicle. For Vitruvius is thinking of 'the centre' not in a mathematical sense, but as an axle or fulcrum. In the explanation of this passage, I have been much assisted by my friend, Professor W. E. Byerly.

10, 6, 4 (259, 13): *in extremo libro eius forma descripta est in ipso tempore.*

The figure here indicated was at the end of the book (*in extremo libro*), and Voss, cited by Schneider, long ago observed that in the additional phrase *in ipso tempore*, the word *tempus* (in its sense of 'temple') seemed to be equivalent to *κρόταφος* as applied to a part of a book in a passage quoted and explained by Suidas from an unknown author. Suidas says: *Κρόταφος τὸ μέρος τοῦ σώματος, καὶ τοῦ βιβλίου τὸ ὀπισθεν μέρος.* "κατὰ τὸν κρόταφον τῆς βίβλου ἐμβαλόντες ἐκμαρτύριον διὰ τινος ἐσχηματισμένου τὴν τέχνην τῶν τὰ τοιαῦτα γραφόντων." The definition of Suidas, however, seems at first thought to give us nothing more than a repetition of *in extremo libro*, but obviously in Vitruvius *in ipso tempore* must add something new to that idea. Consequently it is taken to mean 'on the back' (Marini, Reber), that is, on the reverse of the papyrus. And when we remember the use of the adjective *opisthographus* (e. g. in Pliny, *Ep.* 3, 5, 17 *commentarios opisthographos quidem et minutissime scriptos*; cf. Lucian, *Vit. Auct.* 9), and of the substantive *tergum* (e. g. Juv. 1, 6 *in tergo necdum finitus Orestes*), it becomes probable that this was what both Vitruvius and Suidas meant. Rose in his first edition suggested the emendation *tergore*, but abandoned it in his second, as well he might. The words *κρόταφος* and *tempus* have not been found elsewhere in this sense. But I have observed a usage of *κρόταφος* in Heron which bears some resemblance to it. When one finished reading an ancient book, the beginning of it would have become rolled up inside, and the end would form the outside of the roll. Anything written on the back at the end would therefore be on the periphery of the roll. Now Heron, in the mechanism for his automatic dancing Bacchae, provides a ring fitting about a round stylobate, and adds: *περὶ δὲ τὸν κρόταφον τῆς περιφερείας ἐντετορνέυσθω σωλήν, ἐν ᾧ σπάρτος κτλ.* (1, p. 394, Schmidt), 'round the outer rim (*κρόταφον*) of the periphery a well turned groove, in which a cord, etc.' Here, then, *κρόταφος* is used of the outside of a ring somewhat as the unknown author in Suidas used it of the outside of a roll. I may also remark that in the Arabic version from Philon Byzantius, published by C. de Vaux (*Notices et Extraits*, XXXVIII, 1, 1903, p. 133), is an expression signifying that the figure accompanying the description is 'on the back,' though of course this

figure may possibly not have been placed in a corresponding position in the Greek ms. which the Arabian scribe was rendering. But, it may be asked, how could Vitruvius, while writing the sixth chapter of this book, know that lack of space at the end of the roll (ten chapters follow) would oblige him to put his figure of the water screw on the back? Of course he could not know it, and I believe he added the words *in ipso tempore* to the end of the sentence (where they are rather out of place) after he had finished his book and found that the figure had to be drawn on the back of the roll. I am also inclined to think that he had originally written *descripta erit*, and that he changed *erit* to *est* after he had drawn the figure on the back. For in every other passage where he uses a verb to state the position of one of his figures, he employs the future tense: cf. 75, 8 *in extremo libro erit forma subscripta*; 77, 4 *in extremo libro forma erit descripta*; 80, 4 *in extremo libro forma erit subscripta*; 110, 21 *diagramma subscribam*; 206, 20 *exemplar chorobatae erit in extremo volumine descriptum*; 214, 4 *ut schema subscriptum erit in ima pagina*; 215, 7 *eius rei erit subscripta forma*. The exceptions are only apparent, not real. There are only two of them: 28, 13 *visum est mihi in extremo volumine formas duo explicare*, where *visum est* signifies his intention, not that the figure had already been drawn, and 116, 2, where by *in extremo libro diagramma musica ratione designatum* he means the same *diagramma* that he had promised in 110, 21 to append to his work. If I am right in attributing to Vitruvius a later addition of *in ipso tempore* and a change of *erit* to *est*, may not these alterations, made naturally in the margin of his manuscript, be the ultimate source of the corruption in our manuscripts four lines below, where the words *in illo tempore* (259, 18) are rejected by all critics?

10, 8, 4 (262, 8): *Haec regulae habent ferrea choragia fixa et iuncta cum pinnis, quarum pinnarum tactus motiones efficit regularum continenter.*

In this passage, which forms part of the description of the Water Organ, the word *regulae* denotes the 'sliders' which move back and forth, thus opening and closing the holes which lead to the pipes. The sentence means: 'These sliders have iron *choragia* fastened to them and connected with the keys, which keys when touched make the

sliders move back and forth regularly.' But what are *choragia*? The word is usually rendered 'springs'; for instance, by Rode, Reber, Galiani, and Newton in their translations of Vitruvius, and by Loret in his article on the organ in the *Revue Archéologique* (XV, 1890, p. 91), who is followed by Ruelle in Daremberg and Saglio (s. v. *hydraulus*, p. 314). This is because Heron, in the description of his organ (*Pneum.* 1, p. 200, 4 ff., ed. Schmidt), speaks of springs made of elastic horn, which by means of a cord draw the sliders automatically back into position when the hand is removed from the keys. Hence, Meister emended *choragia* to *chordagia*, and this is approved by Schneider in his Vitruvius (vol. 3, p. 327) and by Schmidt in his translation of Vitruvius on the organ, appended to the first volume of his Heron (p. 503). But in Vitruvius the *choragia* are said to be connected with the *keys*, while in Heron the springs are not connected with them, but communicate with the sliders by means of a cord; and in Vitruvius the word *fixa* cannot signify (according to his frequent usage of it elsewhere) communication by a cord. It must show that the *choragia* are directly fastened to the *regulae*. The *choragia*, therefore, play the part of Heron's ἀγκωνίσκος τρίκωλος (*Pneum.*, p. 198, 9), the surface of the upper joint of which apparently serves as what we call a 'key'; cf. ἀγκωνίσκια (p. 200, 16). But in Vitruvius the *choragia* are not a *part* of the keys (*pinnis*), but are 'connected with the keys.' It seems obvious, therefore, that the mechanism which is denoted in Vitruvius by *choragia* cannot be absolutely identified with any part of the organ as described by Heron, and indeed the two authors do not agree in their accounts of some other details of the instrument. Without here entering into the vexed question of the date of Heron (recently much discussed: see a review of the literature in Bursian's *Jahresbericht*, CXXIX, 1906, pp. 164 ff.), it is safe to say that he and Vitruvius had probably a common source, but that Vitruvius did not follow it very closely, choosing rather to describe the organ as he had seen it (cf. Degering, *Die Orgel*, pp. 38 ff.). With regard to *choragia* we can only say that it denotes the iron mechanism, of whatever sort, by which the key acted upon the slider; the principle of the oscillating lever, the rock-lever, the jointed lever, or of two arms turning upon a centre-pin may have been employed in it. But why was the word *choragia* applied to it? nobody knows. The easiest and safest course is to cry 'corrupt' and

to leave one's dagger beside the corpse; for perhaps one can scarcely venture to point to the very common use of *χορηγέω* in post classical Greek in the sense of 'minister,' 'serve,' 'be agent' (to say nothing of the Aristotelian use of *χορηγία* meaning 'assistance'), and proceed to suggest that perhaps *choragia* (*χορήγια*) somehow came in the language of mechanics to denote the 'agents' or as we might say 'conductors' by which the sliders communicated with the keys. This word 'conductors' happens to be employed by Chappell in his rendering of our passage in his *History of Music* (Vol. I, p. 355), a book, by the way, too little known and scarcely ever quoted (only by Ruelle) in writings on the ancient organ; yet in this book common sense combined with knowledge of music was for the first time (in 1874) applied to the subject. But perhaps if one must select an English word to stand in the place of this very doubtful *choragia*, Gwilt's word 'jack' is the best; for it is a general term still in use to denote the mechanism of any sort by which the keys are enabled to open and close the pipes of an organ.

10, 8, 4 (262, 12): *quibus lingulae omnium includuntur organorum.*

The word *lingula* (*γλωττα*) technically denotes the reed of the *tibia*; see Howard, *The αὐλός or tibia*, *Harv. Stud. in Cl. Phil.* IV, 21 ff. In our passage it will be safest to translate *lingulae* by 'reeds' instead of using the more general term 'mouthpieces.' In this same sentence Vitruvius uses *organorum* to denote 'organ pipes.' He has no occasion to speak of them elsewhere. Heron frequently calls them *αὐλοί* (*Pneum.* I, p. 196, 4 ff., Schmidt), and it is odd that Vitruvius does not use the natural equivalent *tibiae* (cf. Tert. *de anima* 14, *organum hydraulicum dico: . . . tot acies tibiatarum*); but for some reason he chooses the more general term applied to any musical instrument (cf. 9, 15; 110, 12; 112, 8; 136, 2 and 6), which is used also by Quintilian as a synonyme for *tibiae* (11, 3, 20 *ad fin.*), and long before by Aristotle as a synonyme for *αὐλοί* (*Pol.* 3, 1282 b, 34). Neither Vitruvius nor Heron says anything about the material of which the organ pipes were made. It is natural to suppose that in the earliest organs the pipes were made of joints of reed, like the *tibia* and *syrinx*. Whether metal organ pipes were already employed in the time of Vitruvius, it is

impossible to say. The first distinct allusion to bronze organ pipes appears in the Emperor Julian's epigram on the organ (*Anth. Pal.* 9, 365): ἀλλοίην ὁρώω δονάκων φύσιν· ἥ που ἀπ' ἄλλης, χαλκείης τάχα μᾶλλον ἀνεβλάστησαν ἀρούρης, ἄγριοι. For in the *carmen figuratum* of Publ. Optatianus (20 b, ed. Müller), written about 325 A.D., the words *aere cavo et tereti* probably refer to the altar-shaped box (cf. Vitr. 26 I, 3) which held the *pnigeus*.